Personality traits, cardiac risk factors, and their association with presence and severity of coronary artery plaque in people with no history of cardiovascular disease

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Abstract: BACKGROUND Coronary artery disease (CAD) is a multifactorial complex disease. The aim of the present study is to verify whether the personality traits in CAD are associated with coronary artery plaque (CAP) presence and severity in people with no history of cardiovascular disease. DESIGN A cross-sectional monocenter study. METHODS Seventy five individuals with no history of CAD underwent 64-slice computed tomography coronary angiography (CTCA) and were screened for traditional cardiac risk factors and for hostility, anger, and type D personality traits. RESULTS In total, 48 patients (64%) had evidence of CAP, with mild (31%), moderate (33%), and severe (35%) coronary stenosis. Male sex, hypertension, being overweight, and number of cardiovascular risk factors increased the likelihood of CAP presence. Findings showed a significant difference between CAP presence vs. CAP absence for anger (26 vs. 30%, $2 = 6.82$) and type D personality (23 vs. 35%; $2 = 8.23$, $P = 0.03$), but not hostility ($P > 0.05$). Anger personality, and the type D subscale social inhibition, but not negative affectivity, were associated with an increased prevalence and severity of CAP. Univariate analysis confirms anger (odds ratio, OR = 1.38, 95% confidence interval, CI = 1.12-2.31), social inhibition (OR = 2.01, 95% CI = 1.81-2.93), 'negative affectivity by social inhibition' (OR = 1.24, 95% CI = 1.12-2.14), and type D personality (OR = 1.9, 95% CI = 1.11-2.03) as predictors of CAP presence. Moreover, multivariate analysis suggests social inhibition as also a unique CAP predictor (OR = 2.14, 95% CI = 1.89-2.96) after adjustment for having cardiac risk factors as a covariate. CONCLUSION The present data confirm the core role of traditional risk factors and suggest the primacy of social inhibition and anger personality traits in association with CAP presence and severity.

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Keywords: anger, coronary artery disease, coronary stenosis, hostility, type D personality

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Introduction

Traditional cardiac risk factors (CRFs) have shown that older age, higher BMI, male sex, diabetes, hypertension, and dyslipidemia increase the likelihood of the presence of coronary artery plaques (CAPs).[1] Moreover, smoking is associated with acute coronary occlusions of CAP, primarily due to rupture, leading to ST-segment elevated myocardial infarctions.[2] However, while traditional cardiovascular risk factors and algorithms for cardiovascular risk assessment are accurate in population assessment,[3] they may fall short in individual assessment. Indeed, a significant number of cardiovascular events occur either in the absence of known risk factors or in the presence of moderate risk when an aggressive treatment strategy is not indicated. Faletra *et al.*[4] show that 18% of patients who were expected to be at low risk of cardiovascular events, due to absence of CRFs, showed evidence of CAP. Conversely, 12% of patients who had three or more risk factors showed no CAP presence.[4] Moreover, large population studies aimed at investigating the frequency of exposure to major conventional coronary artery disease (CAD) risk factors have shown that 13 and 17% of those with fatal[5] or nonfatal[6] CAD events, respectively, had not been exposed to major risk factors. These data leave room for the hypothesis that other risk factors, such as lifestyle factors, genetic predisposition, or psychological factors,[7] play a potential role in CAP presence, severity, and development.

There is growing evidence that personality traits, such as hostility, anger, and type D personality, contribute to CAD development and prognosis.[8] Hostility, typically described as a negative attitude or cognitive trait directed toward others, has been shown to significantly predict CAD and coronary calcification.[9] A recent meta-analysis demonstrated hostility to be linked to inflammation,

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cardiovascular mortality, and carotid atherosclerosis.[8] Anger is an emotional state that consists of feelings that vary in intensity from mild irritation or annoyance to intense fury or rage, and aggressiveness as a verbal or physical behavioral pattern manifesting as yelling, intimidation, or physical assaults. Anger was found to be associated with CAD incidence, progression of carotid atherosclerosis, and myocardial infarction in large prospective studies.[8,10,11] Type D personality is a relatively stable trait, characterized by high negative affectivity, the tendency to experience negative emotions, and social inhibition, and the tendency to inhibit the expression of emotions/behaviors in social interactions.[12] Studies have shown that type D personality is associated with an increased risk of adverse clinical outcomes in coronary heart disease, including mortality and morbidity.[13]

Taken together, as personality traits are associated with cardiovascular events, it can be hypothesized that they also play a role in the development of CAP. As a first step in unraveling the causality, it needs to be established whether the presence and severity of CAP are associated with personality factors, adjusted for confounders, in a cross-sectional sample. In the present study, we aim to investigate the association between personality traits, hostility, anger, and type D personality, and the presence and severity of coronary atherosclerosis in a cross-sectional group of people with no history of cardiovascular disease.

Methods

Sample and procedure

In the period between October 2009 and July 2010, all patients who received 64-slice computed tomography coronary angiography (CTCA), at the Division of Cardiology of Fondazione Cardiocentro Ticino, Lugano, Switzerland, were informed about the study during their first admission visit. Indications for performing a CTCA were chest pain syndrome, shortness of breath, syncope, or equivocal stress testing including exercise ECG, myocardial perfusion imaging, or stress echocardiography which could not definitively rule significant CAD in or out. Exclusion criteria for performing CTCA were renal insufficiency (serum creatinine 120 mol/l), contraindications to the administration of iodinated contrast, pregnancy, acute coronary syndromes, and ventricular or supraventricular arrhythmias. Exclusion criteria for the present study were having a history of CAD or acute coronary syndrome, having a psychiatric disorder, or being treated with psychotropic drugs. Of the 171 patients who responded positively to the invitation to participate, 92 were excluded either because of history of cardiovascular disease ($n = 74$), having psychiatric disorders, or being treated with psychotropic drugs ($n = 18$). Four participants declined for personal reasons. All 75 participants included in the study provided written informed consent. Psychological questionnaires were filled in at the hospital 2 days before the CTCA scan. Participants were met individually by a certified clinical psychologist for a short clinical interview, and filled out questionnaires.

For each individual, demographic information (marital status and education level), medical history, and detailed physical examination were obtained from the patient medical record. SBP and DBP were measured in sitting position after 5 min of rest using an oscillometric validated device.[14]

Cardiac risk factors

Traditional CRFs were examined: hypertension (arterial blood pressure at least 140/90 mmHg or taking antihypertensive medication);[15] diabetes [nonfasting plasma glucose concentration of at least 11.1 mmol/l (200 mg/dl), fasting plasma glucose level of at least 7.0 mmol/l (126 mg/dl), or being treated with antidiabetic medication];[16] overweight (BMI more than 25 kg/m^2); obese (BMI at least 30 kg/m^2);[17] dyslipidemia [total serum cholesterol level of 6.2 mmol/l (240 mg/dl) or more or a serum triglyceride level of 2.2 mmol/l (200 mg/dl) or more (or both), or use of a lipid-lowering agent];[18] smoking at least one cigarette per day or having quit smoking during the previous year; and family history of CAD [a first-degree or second-degree relative with premature cardiovascular disease (age $\leq$55 years)].

Metabolic syndrome

A proxy measure of the metabolic syndrome was defined according to the International Diabetes Federation (IDF)[19] definition for European populations using the following criteria: presence of central obesity (defined by a BMI of at least 30 mg/m^2), along with two of the following criteria: presence of dyslipidemia; type 2 diabetes; or hypertension.

Coronary stenosis assessment

CTCA assessment of the coronary arteries was performed using the bolus tracking technique (SmartPrep) and a 64-slice CT scanner (LightSpeed VCT; GE Healthcare, Milwaukee, Wisconsin, USA). A more detailed description of the procedure is provided by Faletra *et al.*[4] Image datasets were reconstructed immediately after the scan. Two experienced observers with knowledge of the individual's clinical history and indications for patient referral evaluated the CTCA in a joint reading manner. Coronary obstructions were evaluated by visual assessment comparing the luminal diameter of the segment exhibiting the obstruction to the luminal diameter of the most normal appearing site immediately proximal to the plaque. Coronary lumen narrowing was used to detect the stenosis degree, graded semi-quantitatively and classified as normal (no plaque or up to 30% of coronary lumen diameter), mild (up to 51% of coronary lumen diameter), moderate (51–70%), and severe (>70%). In

case of discordance between the two readers, they proceeded with a consensual re-evaluation. The interrater reliability was high (Cohen's $\kappa = 0.92$).

Personality trait measures

Hostility

Hostility was assessed using the 27-item version of the Cook Medley Hostility Scale,[20] which is thought to reflect the cognitive, behavioral, and mood components of hostility. Items are scored on a dichotomized scale, and the total score reflects the tendency to express cynicism, hostile affect, and aggressive responding. Cronbach's α was 0.87 in the present study. To investigate the prevalence of the hostility trait within discrete categories of CAP severity, in addition to the continuous measure, a psychometric cut-off value based on the Minnesota Multiphasic Personality Inventory (MMPI) manual, using a *T*-score value of at least 65 was used[21] according to standardized tables. A *T*-score value of at least 65 corresponds to a score above the 92th percentile, which equals to a higher level of hostility.

Anger

Anger was measured with the 16-item Anger scale of the MMPI-2 (MMPI-ANG).[21] The MMPI-2 ANG scale is a reliable index of predisposition to the external expression of anger and this scale has been found to be associated with CAD incidence and myocardial infarction in large prospective studies. Items are scored on a dichotomized scale, and the total high score reflects frequent and intense anger, feeling frustrated, being quick-tempered, and being impulsive and prone to interpersonal problems.[10] In the present study, Cronbach's α was 0.79. To investigate the prevalence of the anger trait within discrete categories of CAP severity, in addition to the continuous measure, a psychometric cut-off *T*-value score of at least 65 was used, similar to the hostility score.

Type D personality

Type D personality was measured with the 14-item Type D Personality Scale (DS14).[22] Type D personality is characterized by the tendency to experience negative emotions and not express these emotions in social interactions. It consists of two subscales: negative affectivity and social inhibition. A score of 10 or more on both subscales denotes those with type D personality. In the present study, the internal consistency, calculated by Cronbach's α, for negative affectivity and social inhibition subscales was 0.89 and 0.91, respectively. As has recently been suggested,[23] in addition to the conventional dichotomized construct, either the continuous scores for negative affectivity, social inhibition or the *Z*-transformed continuous scores of negative affectivity and social inhibition and their interaction term [Z (negative affectivity) $\times$ Z (social inhibition)] were investigated.

Statistical analysis

Using a conditional regression model and Monte Carlo simulation, a minimum of 50 patients (25 cases with and 25 cases without CAP) were needed to detect a medium effect, assuming a 1 : 1 ratio with an α-level of 0.05 and power of 0.80. The presence of CAP was estimated as the percentage of patients with stenosis of any degree. Differences among CAP groups were assessed by one-way analysis of variance (ANOVA) for continuous variables, followed by Bonferroni post-hoc test for the severity groups. The Chi-square test was used to compare categorical variables.

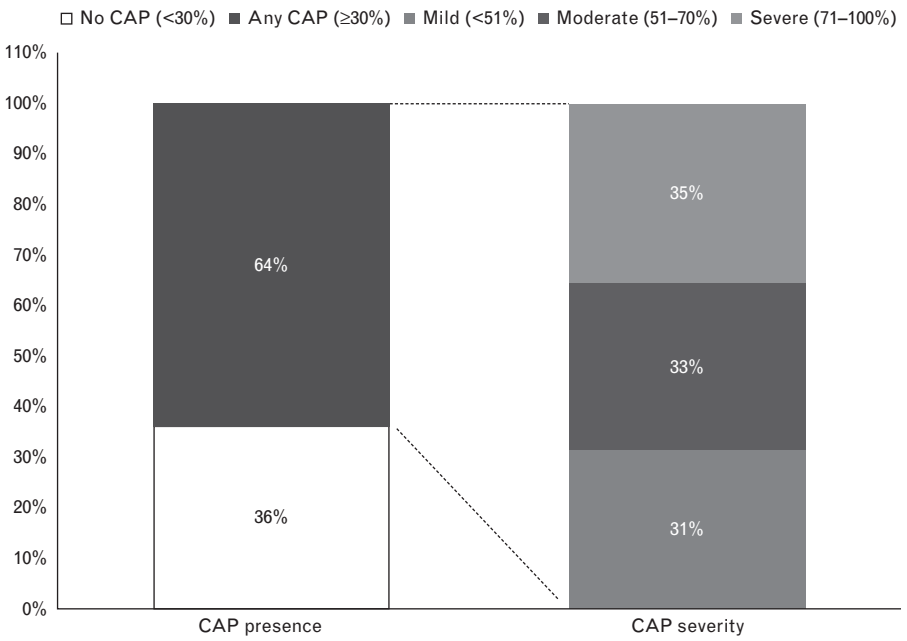
Binary logistic regression (BLR) analysis was used to estimate the association of personality with CAP presence vs. no-CAP presence adjusted for covariates. *Z*-transformed type D dimensions (social inhibition, negative affectivity, and social inhibition by negative affectivity) were used in the BLR analysis. Univariate and multivariate BLR analyses were used to examine the age-adjusted and sex-adjusted odds ratios (ORs) of the individual personality traits separately. An explorative multivariate BLR analysis was performed to examine the effects of the personality measures combined in relation to CAP presence. Before starting the multivariate analysis, we explored the association between personality traits and each CRF using R Pearson correlation for continuous and χ^2 for dichotomized variables. In a first multivariate model, the multiple personality traits were adjusted for age and sex. In a second model, we additionally adjusted for presence of 'one or more CRFs' as a covariate. In an explorative third and subsequent models, we additionally adjusted for each specific CRF associated with personality measure as a result of previous exploratory analysis. The results are presented as adjusted ORs with 0.95 confidence intervals (CIs) and exact *P* values. Statistical significance was accepted as a *P* value of <0.05 (two-sided). Statistical analyses were performed with SPSS version 18.0 for Windows software (IBM; SPSS Institute Inc., Chicago, Illinois, USA).

Results

Clinical characteristics

Figure 1 shows the prevalence of CAP presence and severity in the sample. Group descriptives stratified by CAP presence and severity are reported in Table 1. CAP presence is more prevalent among men, overweight individuals, and those with hypertension and a proxy measure of metabolic syndrome. CAP severity is associated with an increased likelihood of being overweight, having hypertension, diabetes, and metabolic syndrome. Moreover, presence and severity of CAP were associated with an overall increased presence of cardiovascular risk factors. About 34% ($n = 16$) of those with any CAP had an absence of cardiovascular risk factors, whereas 54% ($n = 15$) of those with no CAP had one or more cardiovascular risk factors.

Fig. 1



Prevalence of coronary artery plaque presence and severity in the sample ($n = 75$). CAP, coronary artery plaque.

Personality traits and presence and severity of coronary artery plaque

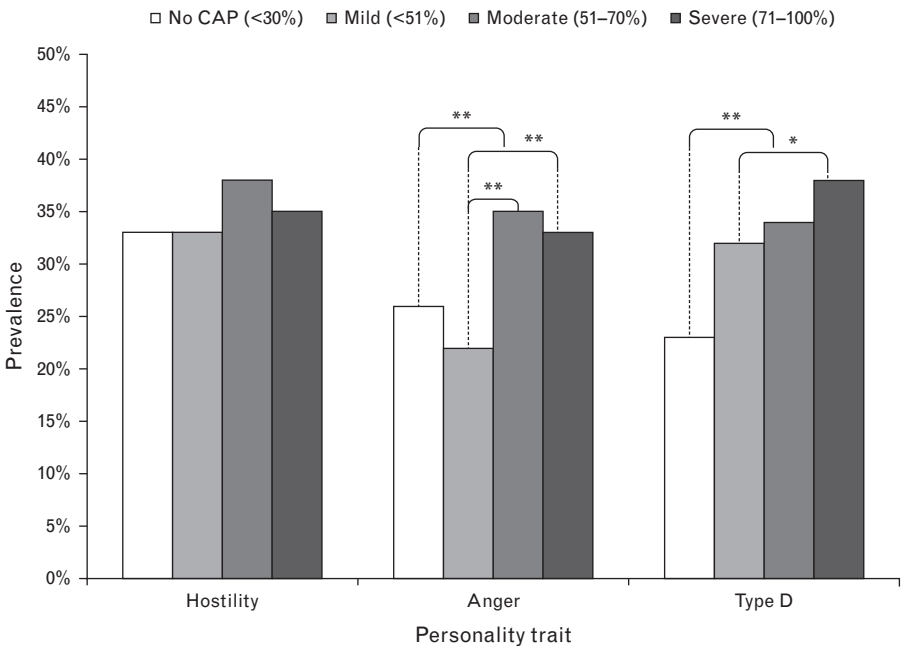
Twenty three patients (31%) in the sample met the type D personality criteria. Figure 2 shows hostility, anger, and type D personality stratified prevalences for CAP presence and severity. Presence of CAP was associated with an increased prevalence of both anger [26 vs. 30%, χ^2 ($n = 75$) = 6.82; $P = 0.04$], and type D personality [23 vs. 35%; χ^2 ($n = 75$) = 8.23, $P = 0.03$], but not hostility [33 vs. 35%, χ^2 ($n = 75$) = 1.35; $P = 0.31$]. There was an increased prevalence of anger and type D personality in the moderate and severe CAP groups, as compared with the mild CAP group (Fig. 2). In accordance with these findings, CAP presence was associated with higher scores of anger, and type D subscale social inhibition (Table 1). In addition, CAP severity was associated with increased levels of anger and social inhibition, but not hostility or the type D subscale negative affectivity. Results of

Table 1 Group descriptives stratified by coronary artery plaque presence and severity

	CAP presence				CAP severity				
	No CAP	Any CAP	Test value	*P*	Mild (<51%)	Moderate (51–70%)	Severe (71–100%)	Test value	*P*
Age	62.1 (8.3)	62.8 (10.4)	0.29	0.32	61.5 (8.4)	57.8 (17.8)	66.8 (8.1)	0.51	0.54
Male sex	11 (41%)	31 (65%)	11.23***	<0.001	10 (67%)	10 (63%)	11 (65%)	0.32	0.32
Married	14 (52%)	26 (54%)	1.35	0.52	9 (60%)	6 (38%)	11 (65%)	1.13	0.12
Cardiovascular risk factors									
BMI	27.2 (3.4)	27.6 (3.9)	0.33	0.40	27.3 (4.5)	28.8 (4.5)	27.6 (3.1)	0.83	0.97
Overweight	15 (56%)	39 (81%)	7.34**	0.01	10 (67%)	14 (88%)	15 (88%)	5.84*	0.03
Hypertension	11 (41%)	28 (58%)	8.29**	0.01	4 (27%)	10 (63%)c	14 (82%)[a]	7.24**	0.01
Dyslipidemia	10 (37%)	17 (35%)	1.12	0.83	5 (33%)	6 (38%)	6 (35%)	1.65	0.63
Diabetes	12 (44%)	21 (44%)	0.89	0.75	3 (20%)	8 (50%)[b]	10 (59%)[c]	5.91*	0.04
Smoking	10 (37%)	16 (33%)	0.76	0.58	5 (33%)	5 (31%)	6 (35%)	0.33	0.42
Family history of CAD	9 (33%)	15 (31%)	0.54	0.93	5 (33%)	5 (31%)	5 (29%)	0.46	0.68
Metabolic syndrome	10 (37%)	23 (48%)	6.94*	0.02	4 (27%)	6 (38%)	13 (77%)[a]	6.24*	0.04
Number of CRF			4.61*	0.03				4.19*	0.03
No CRF	13 (46%)	16 (34%)			6 (43%)	6 (38%)	6 (35%)		
One or more CRF	15 (54%)	31 (66%)			8 (57%)	10 (62%)	11 (65%)		
Personality measures									
Hostility	16.3 (5.8)	17.0 (5.5)	2.31	0.39	16.2 (5.4)	13.8 (8.7)	19.3 (3.03)	1.71	0.88
Anger	13.1 (6.8)	15.7 (6.4)	6.89*	0.03	13.2 (5.5)	17 (8.4)	18.3 (5.9)[c]	4.88*	0.03
Negative affectivity	12.1 (1.9)	13.2 (1.4)	1.12	0.97	11.6 (1.3)	12.7 (1.9)	13.8 (1.4)	2.21	0.14
Social inhibition	9.3 (2.1)	15.6 (1.8)	8.35**	0.01	14.1 (1.6)	14.4 (1.1)	17.1 (1.5)[a]	6.43*	0.02

Variable data are presented as mean (SD), or *n* (%). Test values are *F*, or Pearson χ^2. CAD, coronary artery disease; CAP, coronary artery plaque; CRF, cardiac risk factor.
[a] Severe >moderate and mild; [b] Moderate >mild; [c] Severe >mild. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Fig. 2



Prevalence of personality traits among coronary artery plaque severity classes ($^{*}P<0.05$; $^{**}P<0.01$). CAP, coronary artery plaque.

Bonferroni post-hoc tests showed that patients with severe stenosis (>71% occlusion) reported the highest scores of social inhibition, and higher scores of anger were reported in the moderate and severe CAP group as compared with the mild group. Univariate analysis showed similar findings; after adjustment for age and sex, anger, social inhibition, negative affectivity by social inhibition interaction term, and type D personality were associated with an increased odds for CAP presence (Table 2).

Explorative analyses

Correlation analysis between the personality traits showed a modest correlation of social inhibition (R range from 0.09 to 0.13), negative affectivity (R range from 0.18 to 0.24), anger (R range from 0.14 to 0.27), and hostility (R range from 0.06 to 0.21), respectively with the other personality traits.

Exploration of the association between personality traits and CRF did not show significant results for the continuous BMI. Among the dichotomized CRF variables, there was a significant association between social inhibition and hypertension [52 vs. 14%, χ^2 ($n=75$) = 7.82, $P=0.04$] and between type D personality and the metabolic syndrome [43 vs. 23%, χ^2 ($n=75$) = 6.21, $P=0.04$].

Explorative multivariate logistic regression

In an explorative multivariate logistic regression analysis, adding all personality factors at the same time, social inhibition was the single personality measure associated with CAP presence, when adjusted for age and sex. After further adjustment for having at least one CRF, the odds of social inhibition with CAP presence was slightly attenuated, but remained significant (social inhibition: OR = 1.38, 95% CI = 1.11–1.89). In the complete adjusted model, age (OR = 2.13, 95% CI = 1.34–2.83), and having one or more CRF (OR = 2.43, 95% CI = 1.20–2.97), but not sex (OR = 1.13, 95% CI = 0.93–1.61) were

Table 2 Univariate and multivariate logistic regression analysis of coronary artery plaque presence

	OR	95% CI	*P* value
Univariate age-adjusted and sex-adjusted model			
Personality measure			
Hostility	1.11	0.91–1.58	0.53
Anger	1.38	1.12–2.31	0.04
Negative affectivity[a]	1.04	0.86–1.54	0.61
Social inhibition[a]	2.01	1.81–2.93	0.02
Negative affectivity × social inhibition[b]	1.24	1.12–2.14	0.04
Type D personality[c]	1.19	1.11–2.03	0.05
Multivariate age-adjusted and sex-adjusted model[d]			
Personality measure			
Hostility	1.19	0.95–1.61	0.46
Anger	1.21	0.98–1.83	0.24
Negative affectivity[a]	1.13	0.89–1.44	0.57
Social inhibition[a]	2.14	1.89–2.96	0.02
Negative affectivity × social inhibition[b]	1.15	0.98–1.84	0.32
Type D personality[c]	1.11	0.94–1.42	0.42

CI, confidence interval; OR, odds ratio. [a] *Z*-transformed values. [b] Using the product of the *Z*-transformed negative affectivity and social inhibition variables. [c] The dichotomized type D personality variable was not included in the multivariate analysis. [d] Model: all personality scales are included in this model, adjusted for age and sex.

associated with CAP presence. Additional adjustment for either hypertension or metabolic syndrome slightly increased the odds of social inhibition and the negative affectivity × social inhibition interaction term with CAP presence (social inhibition: OR = 2.19, 95% CI = 1.81–2.37; negative affectivity × social inhibition: OR = 1.89, 95% CI = 1.63–2.26).

Discussion

In the present study, an association between presence and severity of coronary artery stenosis with the personality traits anger, type D personality, and its subscale social inhibition was shown in people with no history of cardiovascular disease. These findings remained after adjustment for age and sex, and explorative adjustment for the presence of having CRFs. Prevalence of type D among patients with CAP and in the whole sample is congruent with those assessed in the community samples. Indeed, the 'TWeesteden mIld STenosis' (TWIST) study[24] reported a type D personality prevalence of 30% in patients with nonsignificant CAD (between 10 and 60% coronary occlusion). In our sample, 30% of patients with nonsignificant CAP ($30 < CAP \leq 70$) have type D personality. Moreover, similarly with findings from study on outpatient participants,[25] our study shows a prevalence of type D personality to be significantly higher in the cases with metabolic syndrome (43%). Finally, congruently with the prevalence rate of 37% assessed in acute myocardial infarction patients,[13,26] our findings show a prevalence rate of 38% in severe stenosis category group.

These findings are in line with other studies investigating the association between personality and subclinical atherosclerosis.[11,27] Findings concerning the personality trait of anger show that baseline anger scores predicted an increase in progression of carotid atherosclerosis assessed by calcium score in a small sample of patients without CRFs,[27] and via intima–media thickness in healthy middle-aged women,[28] in untreated hypertensive men,[28] in a young community sample,[11] and in older adults.[29] Furthermore, these data were confirmed in a recent multiethnic population study.[30] Despite the predictive value remaining not confirmed after multivariate analyses, the present findings show that the anger trait is associated with CAP presence in people with no history of cardiovascular disease after adjustment for age and sex.

Hostility was not associated with subclinical atherosclerosis in the present study. This contradicts findings of the Coronary Artery Risk Development in Young Adults study, which showed a strong predictive value of high hostility scores for having a calcium score of 20 or higher.[9] In contrast, our results are in line with the study of O'Malley *et al.*,[31] which did not find an association between hostility and coronary-calcification score in a large prospective study on patients without known CAD.[31] Moreover, recent findings show that rather than the hostility trait, the aggressive responding component was associated with subclinical atherosclerosis, as examined by platelet aggregation rate,[32] thus further suggesting the importance of the anger trait.

Although type D personality, considered as a dichotomized construct, has repeatedly been associated with poor prognosis and increased risk of morbidity and mortality in cardiac patients (for a review see[33]), there is limited and inconsistent evidence regarding the mechanisms through which type D personality is associated with subclinical atherosclerosis. The present study is an attempt to clarify the role of type D personality, considered both categorically and dimensionally, in the pathogenesis of CAD in people with no history of cardiovascular disease. The findings of our study show that type D personality is associated with coronary artery stenosis presence and severity in people with no history of cardiovascular disease, and suggest a key role for the social inhibition component, after also adjusting for age, sex, and presence of cardiovascular risk factors. The potential mechanisms of the association between type D personality and atherosclerosis have been clarified by recent findings[34] in a population of heart failure patients, suggesting that type D personality is associated with low cardiovascular reactivity to acute mental stress in heart failure patients. The dimensional approach to type D personality analysis shows that social inhibition has the highest predictive value among other personality traits. Denollet[35] defines social inhibition as the 'tendency to inhibit expression of emotions/behaviors in social interaction to avoid disapproval of others' and the tendency to 'feel inhibited, tense, and insecure when with others' (p89). Social inhibition is a construct associated with the processing of emotions and may serve as a 'hub function' for the other personality traits analyzed. A potential mechanism underlying this finding may be via increased sympathetic activation, which has been found to be associated with emotional expressive suppression.[36] Findings from theories of emotion and self-regulation indicate that expressive suppression increases sympathetic activation of the cardiovascular system.[36,37] Additionally, high dispositional negative affectivity or anger may serve to amplify negative emotional responses and this may have biological correlates that stimulate cardiac dysfunction. In contrast to our findings, a study of hospitalized CAD patients[38] did not show an association between type D personality and stenosis severity, as assessed by coronary angiography. Moreover, other studies,[39] addressing the same issue with similar endpoints (coronary artery calcium) have had negative results. Differences in methodology and patient characteristics may explain these different findings.

Limitations

Because of the cross-sectional design and small sample size, no definite conclusions about the potential role of

personality traits in the cause of CAD can be drawn. A clear limitation is the small sample size, which limits generalizability of these findings to other cardiac samples and prevented further adjustment for CRFs, especially for the multivariate conditional logistic regression (CLR) results. The findings from the present study warrant further investigation in large samples to better examine the associations between personality traits and CRFs for CAD.

Another limitation of the present study is that a calcium score was not examined, which, despite representing only 20% of the total atherosclerotic plaque burden,[40] has been shown to be an independent risk factor for CAD.

Because it is important to distinguish between different characteristics of anger (anger expression-out, anger expression-in, anger control-out, anger control-in), having considered anger as a general construct is another limitation.

Conclusion

In conclusion, the present study confirms the core role of traditional risk factors and highlights for the first time the link between social inhibition and anger personality traits, and CAP presence and severity in people with no history of cardiovascular disease. The present results are in keeping with findings from studies showing that personality traits contribute to CAD.[8] This implies that the role of traditional risk factors for CAD may be amplified by the presence of social inhibition and anger personality traits. The key role of social inhibition of negative emotions as a characteristic of type D personality emphasizes the importance of emotional regulation processes in CAD development and prognosis. Further investigation may shed light on these emotional regulatory processes in the links between personality and CAD. Finally, future research, using larger sample sizes, is needed to better define the individual risk of different personality measures and predisposition to CAD.

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Conflicts of interest

A.A. has the following ongoing financial activities outside the submitted work: Sorin, Medtronic, Biotronik, EBR Systems, Abbott, Biologic delivery systems, Cordis Corporation and J&J company. For the remaining authors, none were declared.

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